8.3.8 On March 23 – 24, 2015, the Plaintiffs expert removed Buinewicz Specimen A as well as another window identified herein as Buinewicz Specimens C. GCI noted the following:

a. The location of Buinewicz Specimen A is described in 8.3.7.a above. Buinewicz Specimen C single vent casement window located in the living room on the northwest elevation of the first floor (Figure 139).

b. At both specimens, removal of the windows confirmed that no sealant was installed at the perimeter of the windows between the window frames and the stucco.

c. The rough openings were not flashed prior to installation of the window (Figure 185).

d. No shims were used during installation of the windows.

e. The nailing flanges of the window frames were installed onto the wall sheathing.

f. The WRB is building felt. The WRB was installed over the nailing flanges at all sides of the windows (Figure 181), including the sill, creating a reverse lapped condition that can direct moisture behind the WRB (Figures 183 and 184). The sheathing below Buinewicz Specimen A was wet.

g. No sealant was installed under the nailing flanges (Figures 182) or at the joint where the nailing flanges are inserted into the window frame (Figure 186) as required by the window installation instructions.[162] Also, no sealant was installed where required at the corner adhesive pads (Figure 186).[163] Further, no sealant was installed where it is required on the top outer surface of the frame at the head.[164]

h. Stains at the bottom of Buinewicz Specimens A (Figure 185) where window frame damage was noted does not indicate that moisture is exits from the frame, but instead, that it enter on the side of the opening, behind the unsealed nailing flange, and then flow down to the bottom corner of the window frame and the window opening. This does not support the allegations of Exponent that the slope of the window sill, the size of the gap between the frame sill and the sash, and/or of the weather strip on the sash cause leakage or deterioration of the sash or the window frame.

---

[162] Op. Cit. Kolbe Magnum Casement Installation Instructions, 1997, p. MC7, Bates KOLBE 00095133.
[163] Ibid.
[164] Op. Cit. Kolbe Magnum Casement Installation Instructions, 1997, p. MC6, Bates KOLBE 00095132.

Figure 181

Figure 182

Figure 183

Figure 184

Figure 185

Figure 186

8.3.9 On March 24, 2015, the owner had two windows replaced: a two vent casement window on the front (southeast) elevation of the second floor identified herein as Buinewicz Specimen C (Figures 156 and 159) and a single vent casement window on the southwest elevation (Figure 187) Buinewicz Specimen D. Both windows are in a bedroom at the front left corner of the building. The windows were removed without removing the stucco or the existing nailing flanges. As a result, integration of the WRB to the window was not exposed. As previously noted, it was reported that all the stucco was removed and replaced at the southeast elevation, but it is unknown if this work was also done on the wall with the one vent casement window. The following was observed:

a. No shims were used for installation of either of the windows (Figure 188).
b. No WRB or flashing is wrapped into ether rough opening (Figures 188 and 191).
c. At the twin casement window, a narrow bead of sealant was installed on the exterior perimeter (Figure 190), but the profile is very inconsistent and no backer rod was used. At the single casement window, no sealant was installed (Figure 191).
d. As previously noted herein, the window openings are too large. Removal of the windows demonstrates this. At the twin casement window, the nailing flange at the left jamb (as viewed from the interior) is proud of the wall sheathing approximately $^{7}/_{16}$". At the sill, it is approximately $^{15}/_{16}$" proud of the sheathing (Figure 189) and at the right side, it is approximately $^{5}/_{8}$" proud of the sheathing. At the single casement window, the nailing flange is approximately $^{3}/_{8}$" proud of the sheathing at the left jamb, $^{7}/_{8}$" proud at the head and $^{7}/_{16}$" proud at the right jamb. Nailing flanges are pre-punched with holes for the anchor screws/nails located approximately 1" from the edge of the window. If the opening is properly sized and the window is set square and true, the nailing flange would be approximately ¼" proud of the sheathing, which positions the installation screw/nail at the approximate center of a standard wall stud. Because the nailing flanges are far too proud of the sheathing as noted, the screws that penetrate through the nailing flanges are located near the edge of the wall stud instead of the center of the stud, which greatly jeopardizes the structural integrity of the window frame.

e. At the twin casement window, the intersection of the nailing flanges at the bottom right corner of the window was improper; only a portion of the white corner pad is visible, and the adhesive side of flashing tape is visible at the balance of the corner (Figure 192). No sealant is visible on the inside of the corner as required by the window installation instructions.[165] Staining is present on the wall framing at this corner (Figure 193). Some staining is also visible at the top right corner of the opening (Figure 194).

f. No sealant was installed at the joint where the nailing flanges insert into the window frame at either of the windows (Figure 195).

g. The evidence does not support the allegations of Exponent that the slope of the sill, the size of the gap between the frame sill and the sash, and/or of the weather strip on the sash caused leakage and deterioration of the window sash or frame.

Figure 187

[165] Op. Cit. Kolbe Magnum Casement Installation Instructions, 1997, p. MC7, Bates KOLBE 00095133.

Figure 188

Figure 189

Figure 190

Figure 191

Figure 192

Figure 193

Figure 194

Figure 195

8.3.10 On February 23, 2015, invasive examinations (IE) were made at various locations on the building exterior. For the purposes of this report, these are identified herein as Buinewicz IE 1, 2, 3, and so on. Each IE included making a cut through the stucco to examine the building envelope materials including the sequencing and integration of those materials into the water management system of the exterior wall. GCI's observations were as follows:

a. Buinewicz IE 1 is located at the rear of the home. The cut was made at grade level below a window opening facing the southwest elevation (Figure 196). The window is one that has been previously replaced. The IE revealed that the stucco is installed on metal lath. The WRB is one layer of building felt (Figure 197). There is no wall flashing or stucco screed at the base of the wall. Moisture content of the sheathing at the top of the cut is acceptable, but moisture content of the sheathing at the base of the wall is elevated (Figure 198).

b. Buinewicz IE 2 is located at the bottom corner of Buinewicz Specimen B (Figure 199). The IE revealed that the stucco is installed on metal lath. The WRB is one layer of building felt. The WRB was installed over the nailing flange of the window, including the sill, creating in a reverse lapped installation (Figure 200). As a result, water that enters along the side of the window because sealant was not installed may be able to flow down the outside of the nailing flange and behind the WRB upon reaching the bottom of the window. In addition, this water may be able to flow in behind the nailing flange because the flange was not sealed to the window frame as required, or to the wall (Figure 201), and as a result, this water can flow down and cause damage to the window frame and to the wall. At the bottom left corner of the opening (as viewed from the interior), there is no evidence of any previous water leakage immediately below the window (Figure 202) although the moisture content of the sheathing slightly lower on the wall is moderately elevated. At the opposite bottom corner, the moisture content of the sheathing is highly elevated (Figure 203).

c. Buinewicz IE 3 is located at the bottom corner of Buinewicz Specimen A (Figure 204). The IE revealed that the stucco is installed on metal lath. The WRB is one layer of

building felt. The WRB was installed over the nailing flange of the window, including the sill, creating in a reverse lapped installation (Figure 205). As a result, water that enters along the side of the window because sealant was not installed may be able to flow down the outside of the nailing flange and behind the WRB upon reaching the bottom of the window. In addition, this water may be able to flow in behind the nailing flange because the flange was not sealed to the window frame as required, or to the wall, and as a result, this water can flow down and cause damage to the window frame and to the wall. The moisture content of the sheathing is moderately elevated (Figure 206).

d. Buinewicz IE 4 is located at the top corner of Buinewicz Specimen A (Figure 207). The IE revealed that the stucco is installed on metal lath. The WRB is building felt. The WRB was installed over the nailing flange of the window and a metal drip cap is installed over the nailing flange (Figure 208). The moisture content of the sheathing is normal.

e. Buinewicz IE 5 was an extension of IE 4. The cut was expanded so that the stucco was removed below the soffit adjacent to the roof-to-wall intersection (Figure 209). The moisture content of the sheathing is normal. However, even though this portion of the wall is well protected by the soffit, rusting stains appear in the metal lath and on the WRB indicating the presence of moisture (Figure 210).

Figure 196

Figure 197

Figure 198

Figure 199

Figure 200

Figure 201

Figure 202

Figure 203

Figure 204

Figure 205

Figure 206

Figure 207

Figure 208

Figure 209

Figure 210

8.3.11 Summary of Buinewicz Residence Observations:

a. While there may be some evidence of staining of the sash at the Buinewicz residence, there is no evidence that any of the staining or deterioration is attributable to a window design defect. Exponent has opined that sash staining occurs in the Kolbe casement and awning style windows because of the slope of the window sill, the size of the gap between the frame sill and the sash, because of the weather strip on the sash, and because wood on the underside of the sash is not protected by cladding or paint. However, no evidence has been provided that supports these allegations and Exponent ignored all other potential causes of sash staining. In addition, the evidence indicates that the interior of the windows were finished by the owner or contractor, not by Kolbe, and therefore any exposed wood that may be able to absorb moisture was not caused by a design defect.

b. Numerous construction defects were found that may allow leakage into the building walls, and this leakage can damage the wall, as well as components of the wall such as window frames, resulting in movement, swelling, and distortion, that can affect

window performance. In addition, although the Exponent report alleges that exposed wood on the underside of the sash is not protected by cladding or paint and that this can cause sash damage, the evidence indicates that the interior of the windows were finished by the owner or contractor, not by Kolbe, and therefore the ability of the wood to absorb moisture is due to improper finishing by others, not by Kolbe.

c. Except as otherwise noted herein, the windows at the Buinewicz residence are in generally good condition. The two vent casement window on the front elevation that was replaced on March 24, 2015 and the window in the Living Room identified herein as Buinewicz Specimen A show signs of distress, but in both cases, the windows were installed improperly, and no perimeter sealant was installed around the window frames, flashing was improper. Further, invasive examinations at Buinewicz Specimen A and at other locations in the home revealed that moisture inward of the stucco can enter inward around the unsealed nailing flanges of the window and/or behind the WRB of the window, and this water can then damage the wall sheathing as well as the window.

d. Field testing performed at the Buinewicz residence failed to comply with the applicable testing standards and the results are therefore unreliable. Also, the testing resulted in leakage at one of the two windows tested, but the leakage occurred when the exterior isolation cover failed and allowed water to enter, thereby subjecting the surrounding wall cladding materials to testing along with the window. In addition, invasive examinations revealed that the window nailing flanges were never sealed to the weather barrier on the wall and that the WRB was reversed lapped, directing water inward. Further, the leakage that occurred, when coupled with observations of the window assembly after removal, does not support the allegations of Exponent that water damage and deterioration occur because of the slope of the window sill, or because of the size of the gap between the frame sill and the sash, or because of the weather strip on the sash. Additionally, all the testing, except the first test of each Specimen at 0 p.s.f., was done at wind speeds much greater than the recommendations of the applicable standards and therefore the testing was not in compliance with the applicable standards that require that the tests reproduce the average weather conditions at the site. Also,

field water infiltration testing is to recreate leakage that has been known to occur and the testing agency is to track the water path to identify the source; although not stated in the Exponent report, invasive examinations revealed installation defects that would account for the leakage observed during the testing.

e. Observations of the sash and the window frame between tests at both Specimens indicated that water entered around the sash as expected. Because sash gaskets are installed at the perimeter of the sash, the volume of water entering is small and since the sash gaskets are cut short thereby creating pressure equalization between the exterior of the window and the space surrounding sash, any water that is able to enter and flow downward around the edges of the sash is deposited onto top of the sill member, and the water can then exit to the exterior at the gaps in the sash gaskets. The volume of water that was present on the frame sill and on the underside of the sash at the conclusion of testing was not enough to pool atop the sill but resulted in only intermittently dispersed droplets of water and almost no water on the underside of the sash.

f. Invasive examinations of the building envelope revealed that the stucco application was improper and failed to provide a proper water management system for the exterior building envelope. The exterior stucco was applied without expansion joints and without weep screeds or wall base flashing as required by the applicable stucco installation standards, which as a result, promotes cracking that allows water infiltration and prohibits drainage, trapping water in the wall which can damage the wall as well as the windows in the wall. Also the lack of sealant at stucco terminations and stucco penetrations, including window perimeters, and failure to repair/maintain stucco cracks or other breaches of the building envelope, allows moisture to enter behind the stucco. Water that flows downward behind the stucco collects at horizontal surfaces, including the horizontal wood framing below each window, and failure to provide a proper water management system to drain this water allows the moisture to damage the wall as well as the window.

g. Removal of the windows from the Buinewicz home revealed that they were not

properly installed; the window frames were not set level and square, shims were not used, sealant was not installed on the window nailing fins where required, and flashing of the rough opening was not performed in accordance with the installation instructions of the weather barrier manufacturer. Windows that are not properly shimmed or attached to the building can move out of alignment causing the frame to bow or crown relative to the edge of the sash and this condition can be worsened if moisture or water vapor is also present in the wall. This can result in poor operation of the window as well as poor water drainage from the frame, which can result in deterioration of the sash, particularly if the interior wood of the sash has not been properly protected with finish materials. The interior finish of the windows is brush applied paint, not a factory applied painted finish, and at the window sash that was previously removed and stored in the garage, it was found that the interior painting was done in a manner that left wood on the edges of the sash exposed. In addition, some deterioration was found in the sill of the window opening on the front elevation of the home, but not in the sash, and the frame deterioration is on the face of the window frame which is the sloped area of the frame, while the flat portion of the frame is not deteriorated, all of which contradicts the theories of Exponent.

h. Without an examination of the Buinewicz home, and without an examination of the windows after they were removed from the home, it would not be possible to evaluate all of the building components and all the window installation deficiencies that may have an effect on window performance.

i. Although the evidence indicates that the windows were installed incorrectly and that some other building envelope concerns should be addressed, there is no evidence to indicate that the windows require any sort of repair due to any design or manufacturing defect and there is no evidence to support the allegations of Exponent that the windows must be removed and replaced.

8.3.11 The Buinewicz home has some conditions and findings that may not be typical of the other class members (also see Tables 1 through 4):

a. The original windows are Kolbe all wood casement windows with factory exterior paint

and a field applied interior painted finish;

b. The building site has an escarpment behind the home that may affect winds and exposure of the windows:
c. Drainable hard coat stucco wall cladding;
d. Stucco on the front elevation of the home was removed and replaced;
e. Raised EIFS trim bands around windows on three elevations;
f. Improper clearances between the EIFS trim bands and the window frames;
g. Missing sealant between the EIFS trim bands and the window frames;
h. No weep screeds or wall base flashing at grade level;
i. No control joints for the stucco wall cladding;
j. Improperly lapped weather resistive barrier around the window openings directs water inward onto the window instead of outward over the weather resistive barrier;
k. The contractor failed to properly shim the windows during installation;
l. The contractor failed to properly seal the nailing flange-to-wood frame joint on the window frame prior to window installation;
m. The contractor failed to seal the corners of the nailing flanges properly;
n. The owner or contractor applied paint over portions of the frame gaskets;
o. The owner failed to properly maintain and repair the cracks in the exterior stucco;
q. Burglar alarms drilled through some window sills;
r. Weather records indicate that there is approximately average maximum daily wind speed is 14 mph.
s. Deterioration in the sill of the window on the front elevation that was replaced is on the face of the window frame, which is the sloped area of the frame, while the flat portion of the frame is not deteriorated.

8.4 DELLER RESIDENCE OBSERVATIONS:

8.4.1 GCI inspected the Deller residence located at REDACTED, OH on July 30, 2014. GCI also witnessed field air infiltration and water infiltration testing performed by Exponent on February 4, 2015.

8.4.2 The Deller Residence is a two-story single family home over a basement. A covered entry faces the street on the southeast elevation (Figure 211). The home is located on the south side of a large expanse of open farm land (Figure 212) so there are no sheltering effects on the rear of the home. The side elevations of the home are offered only slight shelter because of adjacent homes. The home is constructed with wood framed walls. The roofing is asphalt shingles with some gutters and downspouts. Conventional roof overhangs provide limited protection to openings since most occur in gable end walls. The exterior wall cladding is cultured stone on the front (Figure 211) and portions of the two side elevations (Figures 213 and 214). Cement fiber board lap siding is used at the balance of the side elevations and at all of the rear elevation (Figure 215). Trim bands around the windows and doors are wood at walls with cement fiber siding, and synthetic stucco at cultured stone (Figure 216).

Figure 211

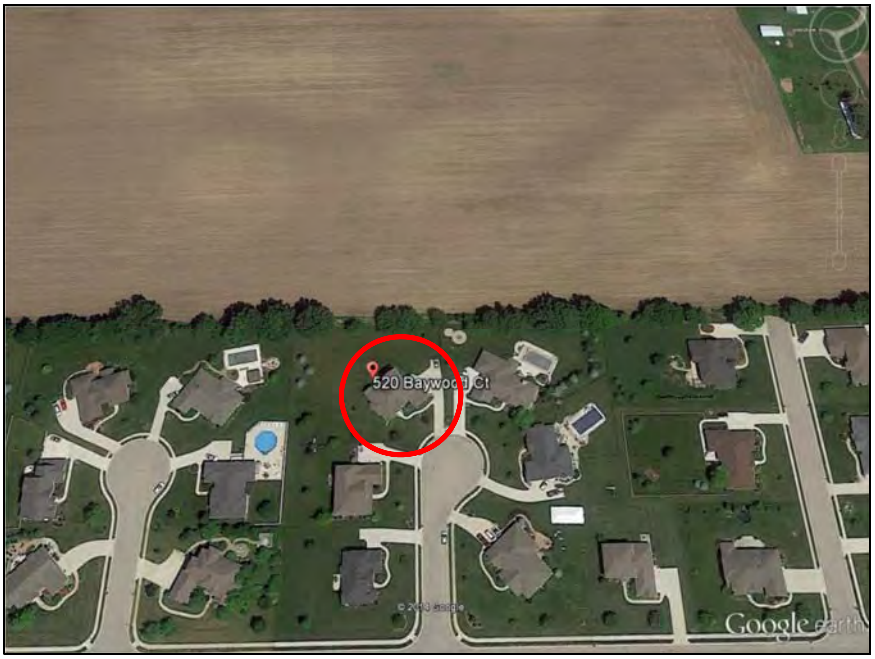

Figure 212

Figure 213

Figure 214

Figure 215

Figure 216

8.4.3 The Kolbe windows are Classic series, wood framed, aluminum clad casement, awning, and fixed direct set windows and one pair of hinged of French patio doors. Order documents indicate the Kolbe products were manufactured in 2004 and that two sash were replaced in 2013. The aluminum cladding on the exterior of the windows and doors has a painted finish. The windows are glazed with double pane LoE insulating glass composed of two glass plies and a stainless steel spacer. The interior of the windows has a stained wood finish that was not applied by Kolbe. The following was noted when inspecting the windows and doors:

a. The joints of the Kolbe window sashes and frames are tightly fitted with neat, hairline joints (Figure 217). Clearances between the sash and window frames are relatively even at the jambs but vary at the sills (Figures 217 and 218). A drip cap is installed above the windows (Figure 219).

b. A raised synthetic stucco trim band on the exterior surrounds the typical window on the front elevation (e.g. Figure 216). Synthetic stucco trim bands are described in paragraph 8.3.5.b above. At the Deller home, the EIFS trim band is generally installed

tightly to the edge of the window and no gap was provided between the side of the window frame and the EIFS for sealant as required by the Kolbe installation instructions[166] (Figures 220 and 221). Instead, only a small thin sealant bead was applied over the surface of the joint (e.g. Figures 221 and 222), but the most vulnerable location, the sill, is generally unsealed (Figures 220 and 222). Some of the sealant has failed (Figures 221, and 223).

c. At windows and doors installed in walls clad with cement fiber board lap siding, a trim board is installed around the window openings (e.g. Figures 224 and 225). Similar to the windows on the front elevation, the trim boards are installed tightly to the window and door frames without a sufficient gap for the installation of sealant and backer rod as required (Figure 224). In addition, the trim boards tightly adjoin each other and it appears that no sealant is installed between them. As a result, any sealant that is installed around the windows and doors, or in joints between the boards, is not able to accommodate movement of the joint. Some of the sealant has failed, and this may allow water to enter (Figures 226 and 227).

d. There is no visible water staining or material degradation on the building interior and except as noted below, the wood along the edges of the window sashes typically have no visible evidence of staining or degradation (e.g. Figure 228). The window frame gaskets appear good with no breaks (e.g. Figure 229), and the sash gaskets appear to be in good condition with standard air gaps at the corners. Edges of the sash have been finished, but it appears that the end grain of the stiles was not sealed prior to application of the stain (Figure 230).

e. At one window in a bedroom on the front elevation of the second floor (Figure 231), the bottom of one of the sashes had an elevated moisture reading at the time of the inspection and the sash-to-frame reveals at the top and bottom of the window sash are uneven (Figures 232 and 233). The exterior perimeter sealant on that side of the window has failed (Figure 232) and the head drip above the window is bent upward so

166 Casement Window Installation Instructions, Kolbe & Kolbe Millwork, Inc., 2003, Figure 1, p. CW1, Bates Kolbe 00095269

far that the top of the window frame is visible (Figures 232 and 234). These conditions and the uneven reveals suggest that the window frame may not have been properly installed and/or water entering around the frame has caused distress such that the sash binds to the frame and can no longer drain water as designed.

`

Figure 217

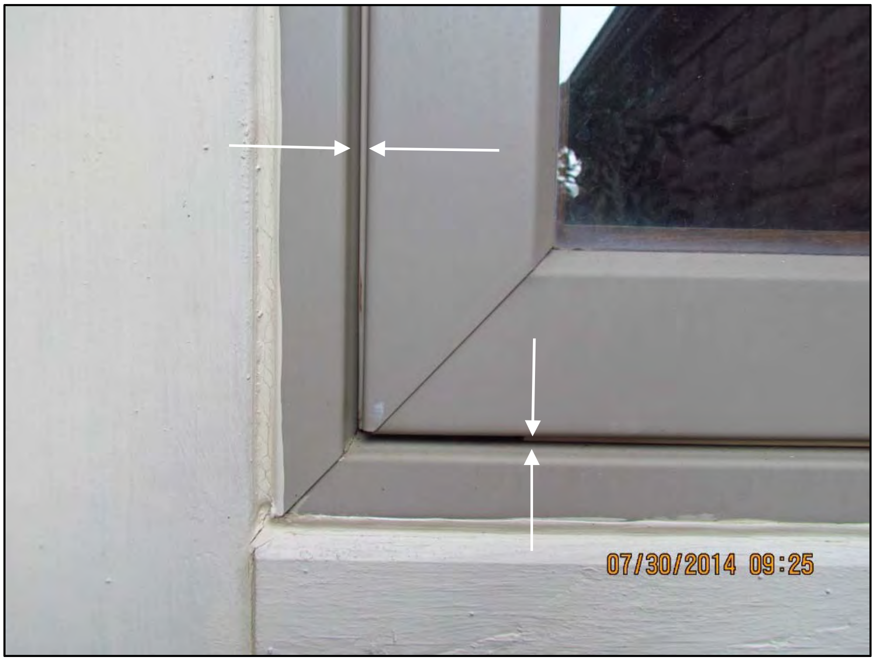

Figure 218

Figure 219

Figure 220

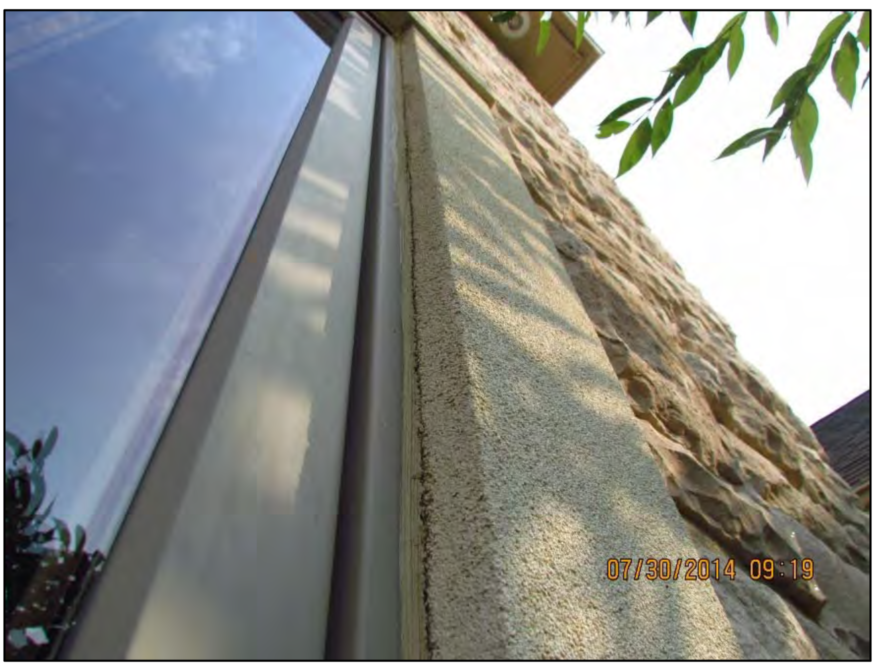

Figure 221

Figure 222

Figure 223

Figure 224

Figure 225

Figure 226

Figure 227

Figure 228

Figure 229

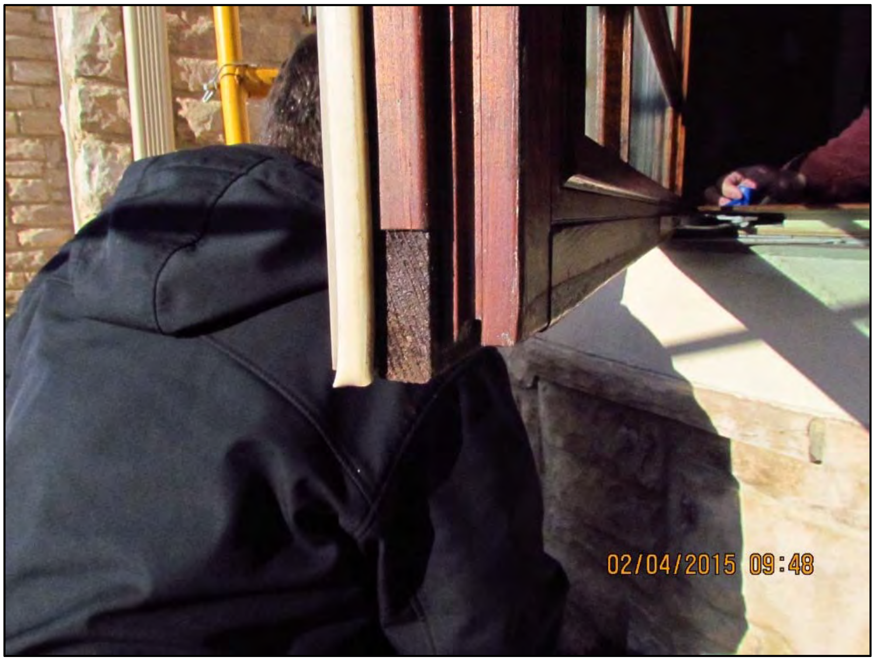

Figure 230

Figure 231

Figure 232

Figure 233

Figure 234

8.4.4 In addition to the issues observed around the windows as noted above, other items were found when inspecting the building exterior that may allow water damage to the walls and the windows. As water enters and migrates down in the walls behind the stucco, it most commonly collects at a horizontal frame member and/or wall opening, and the greatest number these are at windows and doors. Observations included the following:

a. Drainage provisions were incorporated into the exterior walls as can be seen by the end of the weather resistive barrier (WRB) that's visible at some areas near grade level (Figure 235). However, if the cultured stone is set in a full mortar bed as it appears, then the drainage capacity is minimal since the WRB has a smooth texture instead of a grooved texture. A full mortar bed on a smooth texture WRB does not provide the air space that's necessary to allow water drainage and instead, moisture is retained in direct contact with the WRB for prolonged periods. Since the WRB is designed to shed water instead of being in direct contact with water, the moisture can seep through the WRB and enter into the wall, and into the window openings.

b. In many locations where roof kick-out flashing should be installed, none was used and

some of these are located above window openings (e.g. Figure 236). Failure to provide kick-out flashing can allow water entry into the wall which then migrates downward, damaging the wall as well as the windows in the wall.

c. Sealant is installed on the front elevation between the raised trim bands around the windows and the cultured stone, but the sealant has failed (Figures 237 and 238). The sealant failure can allow moisture to enter into the wall between the trim band and the cultured stone, which can then flow downward around the window frames below.

Figure 235

Figure 236

Figure 237

Figure 238

8.4.5 On February 4, 2015, Exponent performed field air and water infiltration testing at two window openings. The windows tested are a twin casement window in the Dining Room and a twin casement window in the Kitchen. For the purposes of this report, these three windows are identified herein as Deller Specimens A and B respectively. My observations were as follows:

a. Deller Specimen A is a twin casement window in the Dining Room on the southeast elevation of the first floor (Figure 239). Deller Specimen B is a twin casement window in Kitchen on the northeast elevation of the first floor (Figure 240). Pre-test examinations revealed that no water stains or material degradation was present on the window sashes, window frames, or on the wood framing or drywall around the window openings (e.g. Figures 241 and 242). No shims were visible at the sills of Deller Specimen A. Neither of the windows were installed plumb, level and square[167].

b. Appendix H to the Exponent report states that Arcadia performed the air testing in

[167] Op. Cit. Exponent report, Appendix H, "Report of Water Infiltration Testing, Deller Residence" Feb. 4, 2015 Arcadia, p. 3

compliance with ASTM E 783[168]. ASTM E 783 does not specify the maximum allowable air leakage. Arcadia states that Kolbe specifies that the maximum allowed air infiltration is to be 0.30 cfm/ft^2,[169] but that is the requirement for laboratory testing of new windows for certification. While there is no standard for allowable air infiltration of aged windows, AAMA 502-12 states that the maximum allowable leakage for installed windows that are less than 6 months old is to be 1.5 times the requirements for laboratory certification testing.[170] Since the maximum air leakage during laboratory testing is to be 0.30 cfm/ft^2, then the maximum allowable air leakage for newly installed windows when tested in the field would be .30 cfm/ft^2 x 1.5 = 0.45 cfm/ft^2, not 0.30 cfm/ft^2 as stated in the Arcadia report. ASTM E 783 requires the pressure measuring devices to be accurate to ±2% or ±0.01 column inches of water (inches H_2O).[171] Two magnehelic manometers were used (Figure 243), one measuring pounds per square foot (p.s.f.) accurate to 0.5 p.s.f. instead of 0.03 p.s.f. as required (1.6 p.s.f. test pressure x .02 = ±0.03 p.s.f.). The other measured inches H_2O accurate to 0.10 inches instead of 0.01 inches as required. The manometers were both vented to the interior instead of the building exterior as required,[172] and indoor and outdoor barometric pressure, temperature, and relative humidity were not reported as required.[173] Arcadia reported that that the testing of Deller Specimen A resulted in air infiltration of 9.0 cfm and that the window area is 27.12 ft^2.[174] Therefore the leakage is 9.0 cfm/27.12 ft^2= 0.33 cfm/ft^2 which is less than the allowable air leakage of 0.45 cfm/ft^2 as stated in AAMA 502-12. Arcadia reported that that the testing of Deller Specimen B resulted in air infiltration of 2.0 cfm and that the window area is 27.12 ft^2.

---

168 Op. Cit. Exponent report, Appendix H, "Report of Water Infiltration Testing, Deller Residence" Feb. 4, 2015 Arcadia, p. 4.
169 Op. Cit. Exponent report, Appendix H, "Report of Water Infiltration Testing, Deller Residence" Feb. 4, 2015 Arcadia, p. 5.
170 Op. Cit. AAMA 502-12, par. 5.2.4, p. 6.
171 Op. Cit. ASTM E 783-02, par. 6.1.3, p. 3
172 Op. Cit, ASTM E 783-02, par. 6.1.1, p. 2-3.
173 Op. Cit. ASTM E 783-02, par. 13.2, p. 4.
174 Op. Cit. Exponent report, Appendix H, Deller Residence "Report of Water Infiltration Testing" by Arcadia ICR, LLC (Arcadia), p. 5.

Therefore the leakage is 2.0 cfm/27.12 ft^2= 0.07 cfm/ft^2 which is less than the allowable air leakage of 0.45 cfm/ft^2 as stated in AAMA 502-12.

c. Water infiltration testing was performed at Deller Specimens A and B. Exponent tested both specimens two times. The first test was performed for 15 minutes at 0 p.s.f. The second test of each Specimen was performed for 17 minutes and consisted of three five-minute long cycles at a static air pressure differential of 1.9 p.s.f. (±27.2 mph) with a 1 minute rest between each cycle. Isolation covers were applied over the surrounding exterior wall cladding materials prior to testing in an attempt to exclude those materials from the testing. The reference standards applicable to field water infiltration testing of windows that are more than 6 months old, such as those at the Deller Residence, are ASTM E 1105, ASTM E 2128, and AAMA 511-08. Both ASTM E 2128 and AAMA 511-08 require that field water infiltration testing be used to recreate leakage that has been known to occur, and it is to reproduce the observed in-service leakage behavior. In addition, AAMA 511-08 provides guidance on how to determine the static air pressure differential, or wind speed, that is to be used for testing, and this is to be based on the historical weather data in the surrounding community.[175] At both Specimens A and B, the static air pressure applied during the second test was 1.9 p.s.f. (±27.2 mph), but weather data from the closest weather station that retains data on wind speed (Dayton, OH) indicates the average daily maximum wind speed in the area is 17 mph (±0.74 p.s.f.).[176] Consequently, it appears that the second test of each Specimen was done at a much greater wind pressures than the recommendations of the applicable standards, which suggests that that pressures selected for these tests were selected according to AAMA 502-12, a standard applicable to field testing of newly installed windows (less than 6 months old). All the above, when coupled with the observations noted below, indicate that testing was not performed in compliance with the applicable requirements and the results are therefore unreliable. The following was noted regarding the testing:

[175] Op. Cit. AAMA 511-08, par. 4.2.1.1, p. 2-3.
[176] Average Weather Data for Dayton, OH, WeatherSpark.com, 2015, p. 10.

1) ASTM E 1105 requires that the pressure measuring device(s) must be capable of measuring the test pressures with an accuracy of ±2% (e.g., 1.9 p.s.f. x .02 = ±0.04 p.s.f.), or ±0.01 column inches of water (col. in. H_2O).[177] However, testing was performed using two magnehelic manometers (Figure 243), one of which measures pressure in pounds per square foot (p.s.f.) with an accuracy of 0.5 p.s.f. instead of the required 0.04 p.s.f. required, and the other measures col. in. H_2O with an accuracy of 0.10 instead of 0.01 as required. The manometers were both vented to the interior instead of the building exterior as required.[178]
3) Deller Specimens A and B revealed no leakage during any of the testing. Following testing it was found that the isolation cover applied over the surrounding wall cladding materials was not water tight and that moisture had leaked into the wall cladding below the window opening (Figure 244).
4) At both Specimens A and B, observations of the sash and the window frames between tests, and at the conclusion of testing, confirmed that, as expected, water enters around the sash. During the second test of both Specimens, Arcadia used moisture sensitive paper between the sash and the frame gasket and the paper extended beyond the gasket onto the wet zone of the window. Subsequent to testing, the paper revealed that moisture was on the frame (Figures 245 and 246). This is not leakage as defined by the standards[179] and water should be expected in that location; because sash gaskets are installed at the perimeter of the sash, the volume of water entering is diminished and since the sash gaskets are cut short, pressure equalization occurs between the exterior of the window and the space surrounding sash so that water that does enter can then exit to the exterior at the gaps in the sash gaskets. Observations revealed that the volume of that was water present on the frame sill at the conclusion of testing was not enough to pool atop the sill but resulted in only intermittently dispersed areas of water approximately 1

[177] Op. Cit. ASTM E 1105-00, par. 6.2.3, p. 2.
[178] Op. Cit. ASTM E 1105-00, par. 6.2.1, p. 2.
[179] Op. Cit. ASTM E 1105-00, par. 3.2.3, p. 1.

to 2 mm deep (Figure 247). Almost no water was on the underside of the sash although discoloration at the end grain revealed that the finish does not adequately protect the wood (Figure 248).

Figure 239

Figure 240

Figure 241

Figure 242

Figure 243

Figure 244

Figure 245

Figure 246

Figure 247

Figure 248

8.4.6 The Exponent report describes the results of "pick tests" performed at several sashes of the Deller home outside of GCI's presence.[180] The report alleges that several of the sashes they tested had evidence of incipient decay. However, as noted above, there is evidence of window installation and construction defects that may have resulted in the uneven sash clearances that were observed at the bottom of the windows. If incipient decay actually exists, this is the <u>result</u> of a problem, not the <u>cause</u>, and the alleged decay is not evidence that the condition resulted because of the slope of the window sill, the size of the gap between the frame sill and the sash, or because of the weather strip on the sash.

8.4.7 Summary of Deller Residence Observations:

a. While there may be some evidence of staining and possible deterioration of the sash at the Deller residence, there is no evidence that any of the staining or deterioration is attributable to a window design defect. Exponent has opined that sash staining occurs in the Kolbe casement and awning style windows because of the slope of the window sill, the size of the gap between the frame sill and the sash, because of the weather strip on the sash, and because wood on the underside of the sash is not protected by cladding or paint. However, no evidence has been provided that supports these allegations and Exponent has ignored all other potential causes of sash staining. In addition, the evidence indicates that the interior of the windows were finished by the owner or contractor, not by Kolbe, and therefore any exposed wood that may be able to absorb moisture was not caused by a design defect.

b. Numerous construction defects were found that may allow leakage into the building walls, and this leakage can damage the wall, as well as components of the wall such as window frames, resulting in movement, swelling, and distortion, that can affect window performance. In addition, although the Exponent report alleges that exposed wood on the underside of the sash is not protected by cladding or paint and that this can cause sash damage, the evidence indicates that the interior of the windows were finished by the owner or contractor, not by Kolbe, and therefore the ability of the wood

---

[180] Op. Cit. Exponent Report, Figure 33, p. 31.

to absorb moisture is due to improper finishing by others, not by Kolbe.

c. Although the field testing methodology used at the Deller Residence was flawed, no water leakage occurred. Observations of the sashes and the window frames between tests indicated that water entered around the sash as expected (see 6.1.3.c above). Because sash gaskets are installed at the perimeter of the sash, the volume of water entering is small and since the sash gaskets are cut short thereby creating pressure equalization between the exterior of the window and the space surrounding sash, any water that is able to enter and flow downward around the edges of the sash is deposited onto top of the sill member, and the water can then exit to the exterior at the gaps in the sash gaskets. The volume of water that was present on the frame sill and on the underside of the sash at the conclusion of testing was not enough to pool atop the sill but resulted in only intermittently dispersed droplets of water and almost no water on the underside of the sash.

d. Without an examination of the Deller home, it would not be possible to evaluate all of the building component deficiencies that may have an effect on window. In addition, no invasive examinations or windows were removed at the Deller home and therefore the effects of improper installation cannot be fully determined. However, as noted previously, removal of the interior trim at the sills of the test specimens did reveal that no shims were installed at the sill of Deller Specimen A and the Exponent report noted that that neither of the specimens windows were installed plumb, level and square. Windows that are not properly shimmed or attached to the building can move out of alignment causing the frame to bow or crown relative to the edge of the sash and this condition can be worsened if moisture or water vapor is also present in the wall. This can result in poor operation of the window as well as poor water drainage from the frame, which can result in deterioration of the sash, particularly if the interior wood of the sash has not been properly protected with finish materials.

8.4.8 The Deller home has some conditions and findings that may not be typical of the other class members (also see Tables 1 through 4):

a. Kolbe Classic windows with aluminum cladding on sash and the frame;

b. Cultured stone exterior wall cladding at a portion of the home that is applied without a drainable WRB;
c. EIFS trim at some windows
d. Sealant failures at the perimeter of the window frames;
e. Sealant failures at joint between EIFS trim and cultured stone
f. Broad, open exposure on the rear elevation;
g. Roof overhangs that offer little protection to any of the windows because of gable end roofing design;
h. Missing kick-out flashing directs water onto window;
i. Damaged/dislocated head flashing above window;
j. Weather records indicate that the average daily maximum wind speed in the area is 17 mph.

8.5 LOHR RESIDENCE OBSERVATIONS:

8.5.1 On August 11, 2014, GCI inspected the Lohr Residence located at REDACTED [redacted] WI. GCI also witnessed the removal of a window at this home on October 2, 2014 and field water infiltration testing of one window on April 16, 2015.

8.5.2 The Lohr residence is a two-story single family home over a basement. A covered entry faces the street on the north elevation (Figure 249). The home is located just south of an open area (Figure 250). Neighboring homes are located on either side. The home is constructed with wood framed walls. The roofing is asphalt shingles and has some gutters and downspouts. Conventional roof overhangs offer some protection to openings immediately below the roof line but far less to those on the lower levels, and the gable end walls on the east and west elevations provide very little protection to openings on those walls. The exterior wall cladding is primarily vinyl lap siding on the north (Figure 249), west (Figure 251), south (Figure 250), and east (Figure 253) elevations. There are also small areas of brick cladding on the north elevation (Figure 249).

Figure 249

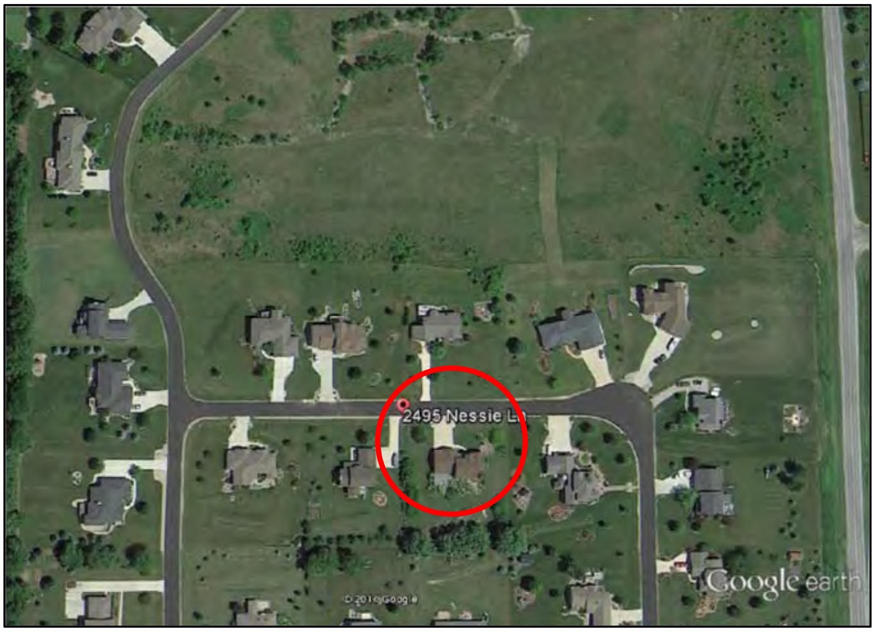

Figure 250

Figure 251

Figure 252

Figure 253

8.5.3 The windows are Kolbe Classic Clad Series, wood framed, aluminum clad, casement windows and one sliding patio door. Order documents indicate the Kolbe products were manufactured in 2000 and that Kolbe replaced several sashes in 2010. The aluminum cladding on the exterior is roll formed and has a painted finish. The windows are glazed with double pane LoE insulating glass composed of two glass plies and a stainless steel spacer. The interior of the windows has a stained wood finish that was not applied by Kolbe. The following was noted when inspection the windows and doors:

a. Typically, the joints of the Kolbe window sashes and frames are tightly fitted with neat, hairline joints (e.g. Figure 254). Clearances between the sash and window frames are relatively even except for some variances at the sill. A drip cap is installed above the windows, but on the north elevation, most of them have been covered with sealant (Figure 255).

b. On the north elevation, PVC trim boards are installed around all the windows (Figures 254 and 255). The trim boards are tightly abutted to the sides of the window frames. There is no gap between the trim board and the window frame for the installation of sealant and backer rod. Instead, a very small bead of sealant has been applied over the exterior face of the window frame and the edge of the trim board, but the sealant bead is too small and improperly configured. Much of the sealant has failed (Figure 256) and this exposes the joint between the window and the trim board, which can allow water to enter. At the balance of the home, vinyl siding trim is installed around the windows (Figure 257).

c. No elevated moisture readings were found in the wood of the sashes, sash stops, extension jambs or stool trim. The frame gaskets appear good with no breaks (e.g. Figure 258), and the sash gaskets appear good and pliable with air breaks at the sash corners (Figure 259). Variations of the interior finish suggest that the field applied interior finish in some areas may only include one coat of clear finish over the stain in lieu of two coats as recommended.[181]

[181] Op. Cit. PDCA P21, par. 5.3.2, p. 2.

d. At several windows, including many with sashes that are dated 2010, there is evidence of moisture collecting on the sash bottom rail (Figures 260) as well as on top of the sash stop on the window sill frame member (Figures 260 and 261). This type of staining commonly occurs because of condensation that forms on the interior glass surface during cold weather days and indicates the interior finish is inadequate to protect the wood.

e. At a window in the basement on the south elevation, sealant has been added to the vinyl siding J-trim on the exterior; this was not done elsewhere at the Lohr home which suggests that this was an attempt to address water leakage problems. The sealant workmanship is very poor (Figure 262). At the bottom of this window, there is staining on the extension trim suggesting that water enters from around the window opening (Figure 263). At grade level of this widow, panels were used as facing on the exterior of the wall, and these extend below grade with unsealed 'H' bars between the panel, which are not waterproof (Figure 264). The sill of the window is close to grade level (Figure 265) although some of the other windows on the basement level are even closer to the grade.

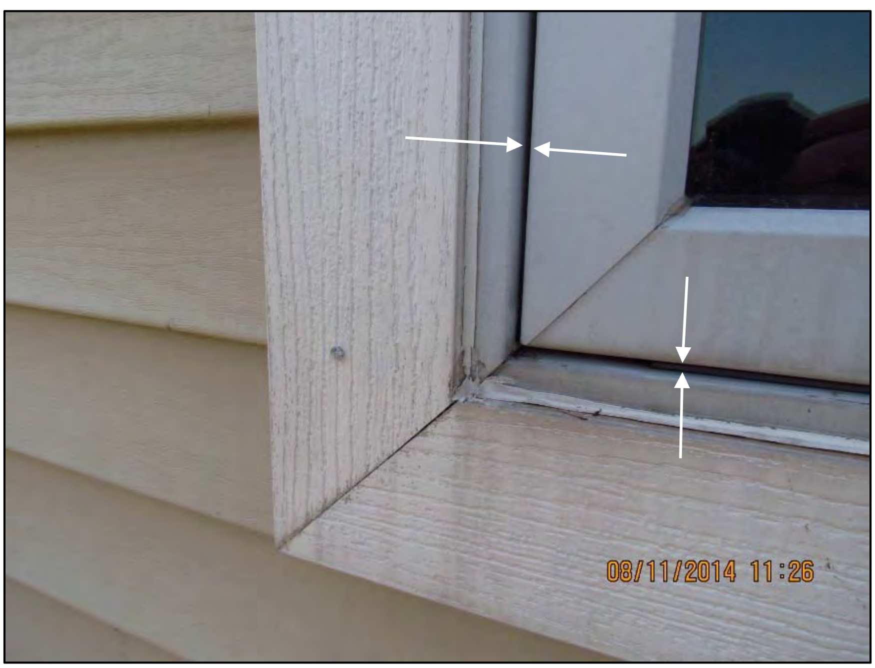

Figure 254

Figure 255

Figure 256

Figure 257

Figure 258

Figure 259

Figure 260

Figure 261

Figure 262

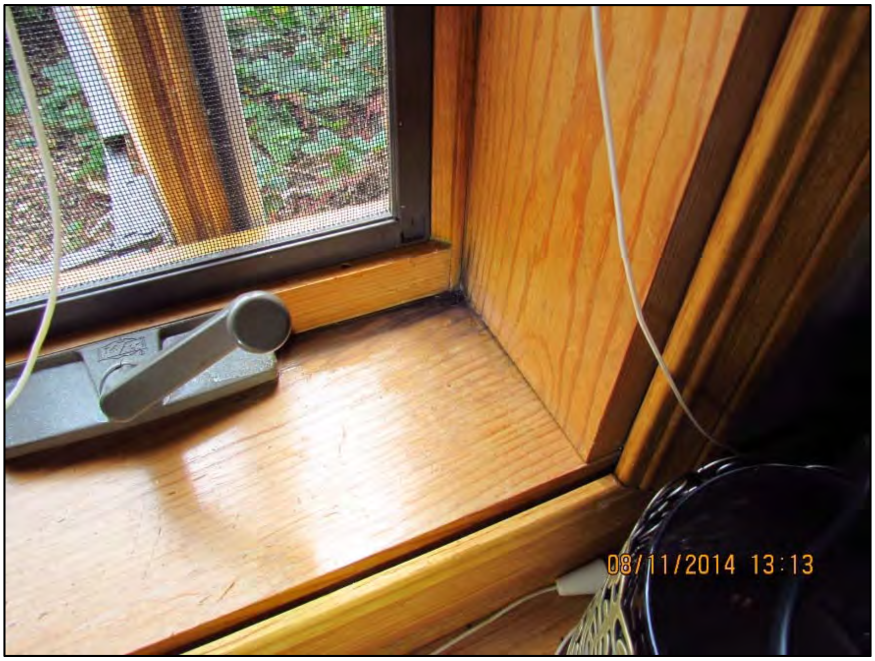

Figure 263

Figure 264

Figure 265

8.5.4 On October 2, 2014, Exponent removed a window on the front elevation for examination (Arrow at Figure 249). This is an operable casement window, but because of its location in a stairwell, the window is only accessible from the interior by use of an extension ladder. The window sashes are original 2000 vintage. GCI's noted the following:

a. The wall sheathing is a rigid foam board with taped joints over oriented strand board. No separate WRB was used. The window nailing is applied directly to the rigid foam board and self-adhesive flashing tape was applied over the nailing fins, onto the rigid foam board (Figure 266). Expanding foam was installed around the interior perimeter of the window, between the window frame and the wall framing.

b. The window frame was installed approximately ¼:" out of square. No shims were used to set the window. The Kolbe installation instructions require that sealant is to be applied to the inward side of the nailing flange where the flange is inserted into the wood window frame.[182] The sealant was not installed (Figure 267).

[182] "Casement Window Installation Instructions," Kolbe & Kolbe Millwork Co., Inc., 2000, p. CW1, Bates Kolbe 0095176.

c. There is very slight discoloration on the rough opening sill (Figure 268). However, the sill of the rough opening had not been flashed. Also, there is no indication of water leakage through the window frame thus indicating that if the discoloration occurred after window was installed, it entered around the perimeter of the opening, not through the window frame joinery.

c.. There is condensation staining on the lower portions of the two sashes and also on the sill stop that is attached to the window frame (Figures 269 and 270). There is no evidence of water leakage through the window frame.

Figure 266

Figure 267

Figure 268

Figure 269

Figure 270

8.5.5 On April 16, 2015, Exponent performed field testing of one window for resistance to air and water infiltration. GCI's observations of this work were as follows:

a. The window selected by Exponent is located on the first floor in the kitchen on the north elevation (Figure 271). For the purposes of this report, the window identified as Lohr Specimen A. The window is located on a covered porch and would not be regularly exposed to rainfall. Prior to testing, examination revealed that some water stains on the portions of the window sashes and on the sill sash stop consistent with that caused by condensation (Figures 272 and 273).

b. Air infiltration testing was performed at Lohr Specimen A. Appendix H to the Exponent report states that Arcadia performed the air testing in compliance with ASTM E 783[183]. ASTM E 783 does not specify the maximum allowable air leakage. Arcadia states that Kolbe specifies that the maximum allowed air infiltration is to be 0.30 cfm/ft^2,[184] but that is the requirement for laboratory testing of new windows for certification. While there is no standard for allowable air infiltration of aged windows, AAMA 502-12 states that the maximum allowable leakage for installed windows that are less than 6 months old is to be 1.5 times the requirements for laboratory certification testing.[185] Since the maximum air leakage during laboratory testing is to be 0.30 cfm/ft^2, then the maximum allowable air leakage for newly installed windows when tested in the field would be .30 cfm/ft^2 x 1.5 = 0.45 cfm/ft^2, not 0.30 cfm/ft^2 as stated in the Arcadia report. ASTM E 783 requires the pressure measuring devices to be accurate to ±2% or ±0.01 column inches of water (inches H_2O).[186] Two magnehelic manometers were used (Figure 274), one measuring pounds per square foot (p.s.f.) accurate to 0.5 p.s.f. instead of 0.03 p.s.f. as required (1.6 p.s.f. test pressure x .02 = ±0.03 p.s.f.). The other measured inches H_2O accurate to 0.10 inches instead of 0.01

---

[183] Op. Cit. Exponent report, Appendix H, "Report of Water Infiltration Testing, Lohr Residence," Apr. 4, 2015, Arcadia, p. 3.
[184] Op. Cit. Exponent report, Appendix H, "Report of Water Infiltration Testing, Lohr Residence," Apr. 4, 2015, Arcadia, p. 5.
[185] Op. Cit. AAMA 502-12, par. 5.2.4, p. 6,
[186] Op. Cit. ASTM E 783-02, par. 6.1.3, p. 3

inches as required. The manometers were both vented to the interior instead of the building exterior as required,[187] and indoor and outdoor barometric pressure, temperature, and relative humidity were not reported as required.[188] Arcadia reported that the testing of Lohr Specimen A resulted in air leakage of 0.5 cfm and that the window area is 12.92 ft^2.[189] Therefore leakage of 0.5 cfm/12.92 ft^2= 0.04 cfm/ft^2 which is less than the allowable air leakage of 0.45 cfm/ft^2 as stated in AAMA 502-12. However, Arcadia also states that the leakage prior to removal of the tare sheet was 23 cfm and the leakage after removal of the tare sheet was 22.5 cfm. If this is correct, it is a negative air loss of 0.5 cfm which is illogical and demonstrates that the testing methodology and/or equipment are unreliable.

c. Water infiltration testing was performed at Lohr Specimen A. Exponent tested the specimen two times. The first test was performed for 15 minutes at 0 p.s.f. The second test was performed for 17 minutes and consisted of three five-minute long cycles at a static air pressure differential of 1.9 p.s.f. (±27.2 mph) with a 1 minute rest between each cycle. Subsequent to testing, the window sashes were opened for examination. Isolation covers were applied over the surrounding exterior wall cladding materials prior to testing in an attempt to exclude those materials from the testing. The reference standards applicable to field water infiltration testing of windows that are more than 6 months old, such as those at the Lohr residence, are ASTM E 1105, ASTM E 2128, and AAMA 511-08. Both ASTM E 2128 and AAMA 511-08 require that field water infiltration testing is to recreate leakage that has been known to occur, and it is to reproduce the observed in-service leakage behavior. In addition, AAMA 511-08 provides guidance on how to determine the static air pressure differential, or wind speed, that is to be used for testing, and this is to be based on the historical weather data in the surrounding community.[190] The static air pressure applied during the second test

---

187 Op. Cit, ASTM E 783-02, par. 6.1.1, p. 2-3.
188 Op. Cit. ASTM E 783-02, par. 13.2, p. 4.
189 Op. Cit. Exponent report, Appendix H, "Report of Water Infiltration Testing, Lohr Residence," Arcadia, p. 4.
190 Op. Cit. AAMA 511-08, par. 4.2.1.1, p. 2-3.

was 1.9 p.s.f. (±27.2 mph), but weather data from the closest weather station that retains data on wind speed (Madison, WI) indicates the average daily maximum wind speed in the area is 18 mph (±0.83 p.s.f.).[191] Consequently, it appears that the second test of Lohr Specimen A was done at a much greater wind pressure than the recommendations of the applicable standards, which suggests that that pressures selected for these tests were selected according to AAMA 502-12, a standard applicable to field testing of newly installed windows (less than 6 months old). All the above, when coupled with the observations noted below, indicate that testing was not performed in compliance with the applicable requirements and the results are therefore unreliable. The following was noted regarding the testing

1) ASTM E 1105 requires that the pressure measuring device(s) must be capable of measuring the test pressures with an accuracy of ±2% (e.g., 1.9 p.s.f. x .02 = ±0.04 p.s.f.), or ±0.01 column inches of water (col. In. H_2O).[192] However, testing was performed using two magnehelic manometers (Figure 274), one of which measures pressure in pounds per square foot (p.s.f.) with an accuracy of 0.5 p.s.f. instead of the required 0.04 p.s.f. required, and the other measures col. In. H_2O with an accuracy of 0.10 instead of 0.01 as required.
2) Lohr Specimen A revealed no water leakage during the testing.
3) Observations of the sash and the window frames at the conclusion testing confirmed that, as expected, water enters around the sash (see 6.1.3.c). However, because sash gaskets are installed at the perimeter of the sash, the volume of water entering is diminished and since the sash gaskets are cut short thereby creating pressure equalization between the exterior of the window and the space surrounding sash, any water that does enter is deposited onto top of the sill member and can then exit to the exterior at the gaps in the sash gaskets. Observations revealed that the volume of water present on the frame sill at the conclusion of testing was not enough to pool atop the sill but only intermittently dispersed areas of water approximately 1

[191] Average Weather Data for Madison, WI, WeatherSpark.com, 2015, p. 10.
[192] Op. Cit. ASTM E 1105-00, par. 6.2.3, p. 2.

to 2 mm deep, and almost no water was on the underside of the sash (Figures 275 and 276).

Figure 271

Figure 272

Figure 273

Figure 274

Figure 275

Figure 276

8.5.6 On April 16, 2015, Exponent removed Lohr Specimen A. GCI's observations were of this work are as follows:

a. The exterior perimeter of the window was face sealed to the PVC casing trim, including at the head. Thus, the sealant was applied over the face of the head flashing (Figure 277). Much of the sealant had failed.

b. The wall sheathing is rigid foam insulation board. Self-adhesive flashing tape is installed over the window nailing flanges and onto the rigid foam insulation board. The edges of the tape do not align with the nailing flange-to-window frame joint, but extend over and onto the side of the window frame cladding (Figure 278). Because of the lap onto the side of the window frame, some wrinkles have occurred (Figure 279). No sealant was used to bed the nailing flanges to the wall sheathing (Figures 280 and 281) or to seal the joint where the window nailing flanges are inserted into the window frame (Figure 282). No sealant was installed at the corner pads on the nailing flanges (Figure 282).

d. No rough opening flashing was provided (Figure 281).

e. No shims were used to square the window frame during installation.

f. There is a slight amount of moisture at the bottom left corner of the window opening that appears to have occurred during the water testing that was done immediately prior to removal of the window (Figure 281). This was not visible during the test and there is no indication of prior moisture entry at this point; it would appear that the leak was induced by the test procedure and not representative of any prior leakage. The moisture originates at the exterior face of the sheathing, indicating that moisture entered around the perimeter of the window, under the nailing flange.

g. There are no leakage stains or deterioration of the window framing or sash (Figures 276 and 282).

Figure 277

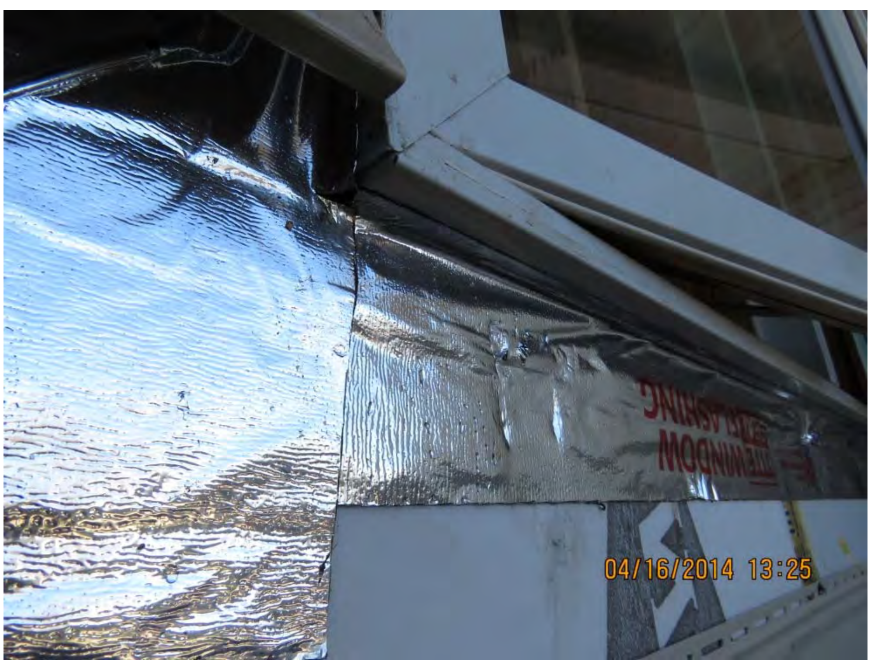

Figure 278

Figure 279

Figure 280

Figure 281

Figure 282

8.5.7 Summary of Lohr Residence Observations:

a. While there may be some evidence of staining of the sash at the Lohr residence, there is no evidence that any of the staining or deterioration is attributable to a window design defect. Exponent has opined that sash staining occurs in the Kolbe casement and awning style windows because of the slope of the window sill, the size of the gap between the frame sill and the sash, because of the weather strip on the sash, and because wood on the underside of the sash is not protected by cladding or paint. However, no evidence has been provided that supports these allegations and Exponent ignored all other potential causes of sash staining. Instead, the evidence indicates that interior condensation has stained the windows, and the location of the staining on the inside surface of the sash and on the top of the sill stop have no relationship to the sill of the window frame. Further, the evidence indicates that the interior of the windows was finished by the owner or contractor, not by Kolbe, and therefore any exposed wood that may be able to absorb moisture was not caused by a design defect.

b. There is evidence that indicates interior condensation has stained the windows and numerous construction defects were also found that may allow leakage into the building walls. This leakage can damage the wall, as well as components of the wall such as window frames, resulting in movement, swelling, and distortion, that can affect window performance. While the Exponent report alleges that exposed wood on the underside of the sash is not protected by cladding or paint and that this can cause sash damage, the evidence indicates that the interior of the windows were finished by the owner or contractor, not by Kolbe, and therefore the ability of the wood to absorb moisture is due to improper finishing by others, not by Kolbe.

c. The windows at the Lohr Residence are in generally good condition. However, condensation may have occurred on the inside of some of the windows in the Lohr home. Condensation forming on a window is not a window defect; windows do not cause condensation any more than an automobile windshield is the cause of condensation on a cold day, or a drinking glass is the cause of condensation when filled with ice water. Instead, condensation is the result of temperature, relative humidity,

air flow, and thermal transmittance. Warm air, such as heated air inside a building, contains water vapor, and when the indoor air contacts a cold surface such as window glass, a bathroom mirror, or a drinking glass, the moisture in the air will condense to a liquid. Stains as at the Lohr windows suggest that the interior wood surfaces were not properly finished to protect against this condensation moisture. Further, although the Exponent report alleges that exposed wood on the underside of the sash is not protected by cladding or paint and that this can cause sash damage, the evidence indicates that the interior of the windows were finished by the owner or contractor, not by Kolbe, and therefore the ability of the wood to absorb moisture, whether on the underside of the sash or around the nails in the glass stops, is due to improper finishing by others, not by Kolbe. Also, the presence of condensation, should it occur, is on the inside of the window sash and therefore on the inward side of the frame gasket. Thus, this moisture never enters underneath the window sash, but is contained on the inside of the sash.

d. Although the field testing methodology was flawed, no water leakage was observed during field testing of a window at the Lohr Residence. The water applied during field testing is far greater than actual conditions; weather data indicates that the vast majority of rain conditions in the area is light to moderate rain. In addition, the standards require that testing is to be performed in a manner that reproduces the average weather conditions, but testing was actually performed at static air pressure differentials much greater than the averages in the area. Further, field water infiltration testing is to recreate leakage that has been known to occur, but there is no evidence that water leakage has ever occurred at the Specimen tested. Consequently, the leakage that became visible after removal of the Specimen was not a recreation of a water leakage problem, but instead, the testing created leakage that otherwise does not occur because of the procedure that was used.

d. Observations of the sash and the window frame between water tests indicated that water enters around the sash as expected. Because sash gaskets are installed at the perimeter of the sash, the volume of water entering is small and since the sash gaskets are cut short thereby creating pressure equalization between the exterior of the window and

the space surrounding sash, any water that is able to enter and flow downward around the edges of the sash is deposited onto top of the sill member, and the water can then exit to the exterior at the gaps in the sash gaskets. The volume of water that collected on the sill after two water tests was not enough to pool on the flat portion of the sill below the sash, but only intermittently dispersed areas of water were present, approximately 1 to 2 mm deep, and very little water was on the underside of the sash.

e. Removal of two windows from the Lohr Residence revealed that the windows were not installed properly; sealant was not installed on the window nailing fins where required, the window frames were not properly shimmed, and flashing of the rough opening was not performed in a manner that assures the rough opening is watertight. The removal also revealed that there is no evidence of water leakage through the window frame joinery. Windows that are not properly shimmed can move out of alignment causing the frame to bow or crown relative to the edge of the sash and this condition can be worsened if moisture or water vapor is also present in the wall. This can result in poor operation of the window as well as poor water drainage from the frame, which can result in deterioration of the sash, particularly if the interior wood of the sash has not been properly protected with finish materials and if the interior surfaces are subjected to condensation moisture as has occurred at the Lohr home.

f. Without an examination of the Lohr home, and without an examination of the windows after they were removed from the home, it would not be possible to evaluate all of the building components and all the window installation deficiencies that may have an effect on window performance.

8.5.8 The Lohr home has some conditions that may not be typical of the homes of the other class members (see also Tables 1 through 4):

a. Kolbe Classic Clad Series windows with aluminum cladding on sash and on the frame;
b. Remedial sealant at some windows, but poorly installed and failing;
c. Roof overhangs, where they occur, provide some protection to windows on the upper floor, but not the lower floor, and gable ends roofs provide little protection to openings;
d. Condensation staining on the interior of the windows indicates a failure to control the

indoor humidity and air flow;

e. Condensation staining on the interior indicates the interior finish applied by the owner or contractor was not sufficient to protect the wood from staining;
f. The contractor failed to seal the nailing fin to the window frame as required;
g. The contractor failed to seal the corner pads to the window nailing flanges as required;
h. The contractor failed to flash the window openings;
i. The contractor installed flashing tape of the nailing flanges that laps outward onto the side of the window frame;
j. The contractor failed to shim the windows during installation;
k. Weather records indicate the average daily maximum wind speed in the area is 18 mph.

8.6 McIVER RESIDENCE OBSERVATIONS

8.6.1 GCI inspected the McIver Residence located at REDACTED, MI on August 14, 2014. GCI also witnessed field air infiltration and water infiltration testing performed by Exponent on January 12, 2015 at which time GCI also witnessed the removal of the two windows that were tested.

8.6.2 The McIver residence is a split level, single family home. A covered entry faces the street on the south elevation (Figure 283). The home is in an urban setting; the east (Figure 284), west (Figure 285) and north elevations (Figure 286) face adjacent residential properties. The roofing is asphalt shingles with some gutters and downspouts. Conventional roof overhangs provide some protection to window openings immediately below the roof on the west elevation and at the covered entry on the south. The roof overhangs provide little protection to windows in the gable end walls or to windows on the basement level. The exterior walls are wood frame construction. The exterior wall cladding at the two story portion of the home is brick on the basement level and rough cut wood horizontal lap siding at the second floor. At the first floor level, the exterior wall cladding includes both brick and Texture 111 siding.

Figure 283

Figure 284

Figure 285

Figure 286

8.6.3 In addition to the Kolbe products discussed herein, there is also a window opening and a sliding patio door on the north elevation that are not Kolbe products (arrows at Figure 286).

8.6.4 The Kolbe windows are all wood double hung windows with brickmould trim. There is also one casement window on the front elevation in the kitchen and one on the right side in the garage. Documentation indicates that the windows were manufactured in 2000. The exterior of the windows has a factory K-Kron painted finish. The interior finish at the double hung windows is stained and the casement window in the kitchen is painted. Order records for the windows do not specify any interior finishing and the interior painted finish is brush applied, not a spray applied as a factory finish would be. The windows are glazed with double pane LoE insulating glass composed of two glass plies and a stainless steel spacer. The following was noted when inspecting the windows and doors:

a. Wood-to-wood joints of the Kolbe window sashes and frames are typically tightly fitted with neat, hairline joints (Figures 287, 288, and 289). Window frame gaskets appear good with no breaks and sash gaskets appear good and pliable. The owner/contractor applied interior painted finish does not extend to the edges of the sashes at the casement

window (Figure 290).

b. A drip cap is installed above the windows in walls with lap siding and with Texture 111 siding, but some of the drip caps have a reverse slope back towards the siding (Figures 288 and 292). No drip cap is installed in the brick walls (Figure 289).

c. The rough cut lap siding at the second floor level was cut to fit around the windows. In some cases, a gap with sealant can be seen between the window and the siding (below window sill at Figure 291), but in most cases the siding tightly abuts the window leaving no gap for the installation of sealant and backer rod as is required by the Kolbe installation instructions.[193] Instead, a bead of sealant was applied over the surface of the siding and onto side of the brickmould trim. The size of the sealant bead is too small and poorly configured. Much of the sealant has failed, which can allow water to enter (Figure 292).

d. At brick clad walls, there is no gap between the jamb brickmould trim and the brick for the installation of sealant and backer rod as recommended by the Kolbe installation instructions[194, 195] and by the BIA[196] (Figures 287 and 293). Instead, sealant is installed over the face of the brickmould and onto the brick, but workmanship in some areas is very poor (Figures 293 and 294). Much of the sealant has failed (Figures 294, 296 and 297). At the head, a wood filler strip is installed. It appears that the filler strip is installed over the substrate materials, but no sealant was used between the filler strip and the brickmould or between the filler strip and the steel lintel above (Figure 295), and as noted previously, no head drip cap is present. Without the appropriate sealant, water and air can infiltrate inward of the window framing.

e. The sills of the windows on the basement level are at or near grade level (Figure 293, 294, and 296), and on the front elevation, the grade slopes towards the window sills

---

[193] "Double Hung and Slider Window Installation Instructions" Kolbe & Kolbe Millwork Co., Inc., 2000, Fig 1, p. DHSL 1, Bates Kolbe 00095180.

[194] Op. Cit. Kolbe Double Hung and Slider Window Installation Instructions, 2000, p. DHSL 3, Bates Kolbe 00095182.

[195] Op. Cit. Kolbe Casement Window Installation Instructions, 2000, p. CW3, Bates Kolbe 00095178.

[196] Technical Notes 28 "Anchored Brick Veneer, Wood Frame Construction", The Brick Industry Association (BIA), Aug. 1991, "Sealant Joints", p. 5.

(Figure 296). Consequently, the sills of the basement windows are highly susceptible to ground water, and even if the brick rowlock sill below the windows has been flashed as required by the BIA, although it does not appear to be, the flashing could not drain as required since the flashing would be below grade. In addition, the window frame sill member at all these window frames is set directly onto the brick rowlock sill without any clearance as required by the BIA[197] and by the Kolbe installation instructions[198] (Figures 293, 294, 297 and 298). Because clay brick absorbs moisture, the sealant does not stop the flow of moisture through the brick and therefore the wood window frame that is in direct contact with the brick will be wetted.

f. A Kolbe window on the east elevation of the garage appears to have been installed on top of the original sill window trim, but it is not sealed to the old trim (Figure 299). The jamb brickmould trim is face sealed to the Texture 111 siding, but the sealant has failed (Figure 300). A drip cap is installed above the head brickmould, but it is reverse sloped (Figure 288). On the interior, no interior finishes are installed (Figure 301) and water stains are visible on the wall framing (Figures 302 and 303), but no stains are visible on the window frame joinery. No window wrap flashing or weather resistive barrier is installed into the rough opening (Figures 302 and 303). The opening was not properly filled or adjusted to fit the window, so there are large gaps between the window frame and the wall framing (Figure 304), but no shims or frame anchors are visible as required by the Kolbe installation instructions[199] (Figures 302, 303, and 304). The inward facing side of the brickmould is visible in these gaps, and no sealant was installed at the brickmould-to-window frame joint as is required by the Kolbe installation instructions[200] (Figure 304). No sealant ooze-out is visible at the edge of the brickmould where it laps over the sheathing as would be expected had sealant been installed prior to installation of the window (Figures 302 and 304).

---

[197] Ibid.
[198] Op. Cit. Kolbe Double Hung and Slider Window Installation Instructions, 2000, p. DHSL 3, Bates Kolbe 00095182.
[199] Op. Cit. Kolbe Casement Window Installation Instructions, 2000, p. CW 2, Bates Kolbe 00095177.
[200] Op. Cit. Kolbe Casement Window Installation Instructions, 2000, p. CW 1, Bates Kolbe 00095176.

g. No elevated moisture readings were found in the wood of the sash, sash stops, extension jambs or stool trim, however, elevated moisture readings were found in the sill of the center window of a triple unit located in the basement on the north elevation (Figure 286) indicating that moisture is collecting under the frame sill (Figure 305). As previously noted, the sills of the windows on the lower level are located at, or nearly at, grade level and also, the sealant applied here has failed and the window frames are set directly onto the brick which absorbs moisture. Of note, there are seven windows on the basement level and the owner has marked eight windows in the home with alleged problems, seven of which are basement windows. The one window on the second floor that was marked by the owner may have been marked because of blistering paint on the sill (Figure 306). The sealant at this window has failed (Figures 307 and 308). In addition, installation conditions at this window appear no different than those uncovered upon removal of McIver Specimen B, and as explained below, evidence indicates that sealant and flashing defects allow water to enter around the window, and this has caused damage to the window.

Figure 287

Figure 288

Figure 289

Figure 290

Figure 291

Figure 292

Figure 293

Figure 294

Figure 295

Figure 296

Figure 297

Figure 298

Figure 299

Figure 300

Figure 301

Figure 302

Figure 303

Figure 304

Figure 305

Figure 306

Figure 307

Figure 308

8.6.5 In addition to the items already noted, other items were found when inspecting the building exterior that may allow water damage to the walls and the windows. As water enters and migrates down in the walls behind the brick, it most commonly collects at a horizontal frame members and/or wall opening, and the greatest number these are at windows and doors. Observations included the following:

a. No flashing is visible at roof-to-wall terminations. Instead, the siding is caulked to the roofing shingles (Figures 309 and 310).

b. No kick-out flashing is installed at the bottom end of roof-to-wall terminations (Figures 309 and 310).

c. Unlike the Kolbe windows, the non-Kolbe window and patio door on the rear elevation were installed with raised trim surrounds that was clad with aluminum (Figure 311) and the cladding trim was fully sealed to the surrounding wall siding.

Figure 309

Figure 310

Figure 311

8.6.6 On January 12, 2015, Exponent performed field air infiltration testing of one window, and field water infiltration testing of two windows. The windows tested were a twin vent casement window on the south elevation in the Kitchen (Figure 312) and a double hung window on the north elevation in the Master Bedroom (Figure 313). For the purposes of this report, these are identified as McIver Specimens A and B respectively. GCI's observations of this work were as follows:

a. At McIver Specimen A, no water stains were visible on the window sashes, frames, or on the wood framing around the window opening (Figure 314), however, upon removal of insulation from above the head of the window, condensation moisture was found on the insulation above the head of the window and on the back of the brickmould trim (Figure 315). The window was installed approximately $^{1}/_{8}$" out of square. At McIver Specimen B, the exterior sealant has failed (Figure 316 and 317) and the head drip is reverse sloped (Figure 317). The sill is not sealed to the siding (Figure 318) and there is visible degradation of the brickmould trim at the jamb on the east side of the window

(Figure 319). The window was not installed plumb.[201]

b. Air infiltration testing was performed at McIver Specimen B only, but Appendix H to the Exponent report does not discuss this test and provides no explanation of why it was not included. All other air tests described in Appendix H to the Exponent report indicate that Arcadia attempted to perform testing in compliance with ASTM E 783. While there is no standard for allowable air infiltration of aged windows, AAMA 502-12 states that the maximum allowable leakage for installed windows that are less than 6 months old is to be 1.5 times the requirements for laboratory certification testing.[202] Since the maximum air leakage during laboratory testing is to be 0.30 cfm/ft^2, then the maximum allowable air leakage for newly installed windows when tested in the field would be .30 cfm/ft^2 x 1.5 = 0.45 cfm/ft^2. ASTM E 783 requires the pressure measuring devices to be accurate to ±2% or ±0.01 column inches of water (inches H_2O).[203] Two magnehelic manometers were used, one measuring pounds per square foot (p.s.f.) accurate to 0.5 p.s.f. instead of 0.03 p.s.f. as required (1.6 p.s.f. test pressure x .02 = ±0.03 p.s.f.). The other measured inches H_2O accurate to 0.10 inches instead of 0.01 inches as required. The manometers were both vented to the interior instead of the building exterior as required,[204] and indoor and outdoor barometric pressure, temperature, and relative humidity were not reported as required.[205] At the site, Arcadia reported that that the testing of McIver Specimen B resulted in air leakage of 3.0 cfm and the window area is 12.34 ft^2. Therefore the leakage is 3.0 cfm/12.34 ft^2= 0.24 cfm/ft^2 which is less than the allowable air leakage of 0.45 cfm/ft^2 as stated in AAMA 502-12.

c. Water infiltration testing was performed at McIver Specimens A and B. Exponent tested Specimen A three times and Specimen B two times. The first test of McIver

201 Op. Cit. Exponent report, Appendix H, "Report of Water Infiltration Testing, McIver Residence," Jan. 12, 2015, Arcadia, p. 3.
202 Op. Cit. AAMA 502-12, par. 5.2.4, p. 6,
203 Op. Cit. ASTM E 783-02, par. 6.1.3, p. 3
204 Op. Cit. ASTM E 783-02, par. 6.1.1, p. 2-3.
205 Op. Cit. ASTM E 783, par. 13.2, p. 4.

Specimen A was performed for 15 minutes at 0 p.s.f. The second test of McIver Specimen A was performed for 17 minutes and consisted of three five-minute long cycles at a static air pressure differential of approximately 2.0 p.s.f. (±27.9 mph) with a 1 minute rest between each cycle. The third test of McIver Specimen A consisted of three five-minute long cycles at a static air pressure differential of 5.0 p.s.f. (±44.2 mph) with a 1 minute rest between each cycle. Subsequent to each test of McIver Specimen A, the window sashes were opened for examination. The first test of McIver Specimen B was performed for 15 minutes at 0 p.s.f., and the second test was performed for 17 minutes and consisted of three five-minute long cycles at a static air pressure differential of approximately 1.3 p.s.f. (±22.5 mph) with a 1 minute rest between each cycle. Isolation covers were applied over the surrounding exterior wall cladding materials at both specimens prior to testing in an attempt to exclude those materials from the testing. The reference standards applicable to field water infiltration testing of windows that are more than 6 months old, such as those at the McIver Residence, are ASTM E 1105, ASTM E 2128, and AAMA 511-08. Both ASTM E 2128 and AAMA 511-08 require that field water infiltration testing is supposed to recreate leakage that has been known to occur, and to reproduce the observed in-service leakage behavior. In addition, AAMA 511-08 provides guidance on how to determine the static air pressure differential, or wind speed, that is to be used for testing, and this is to be based on the historical weather data in the surrounding community.[206] At McIver Specimen A, Exponent elected to test at static air pressures of 0 p.s.f., approximately 1.9 p.s.f. (±27.2 mph) and 5.0 p.s.f. (±44.2 mph) while at McIver Specimen B, Exponent elected to test at static air pressures of 0 p.s.f. and 1.3 p.s.f. (±22.5 mph). Weather data from the closest weather station (Kalamazoo, MI) indicates the mean average daily wind maximum speed in the area is 16 mph (±0.65 p.s.f.).[207] Consequently, it appears that the all the testing except the first test of each Specimen was done at wind pressures much greater than the recommendations of the applicable

---

[206] Op. Cit. AAMA 511-08, par. 4.2.1.1, p. 2-3.
[207] Average Weather Data for Kalamazoo, MI, WeatherSpark.com, 2015, p. 10.

standards, which suggests that that pressures selected for these tests were selected according to AAMA 502-12, a standard applicable to field testing of newly installed windows (less than 6 months old). All the above, when coupled with the observations noted below, indicate that testing was not performed in compliance with the applicable requirements and the results are therefore unreliable. The following was observed during the testing:

1) ASTM E 1105 requires that the pressure measuring device(s) must be capable of measuring the test pressures with an accuracy of ±2% (e.g., 1.9 p.s.f. x .02 = ±0.04 p.s.f.), or ±0.01 column inches of water (col. In. H_2O).[208] However, testing was performed using two magnehelic manometers (Figure 320), one of which measures pressure in pounds per square foot (p.s.f.) with an accuracy of 0.5 p.s.f. instead of the required 0.04 p.s.f. required, and the other measures col. In. H_2O with an accuracy of 0.10 instead of 0.01 as required.
2) McIver Specimen A revealed no water leakage in the first at 0 p.s.f. or the second test at approximately 1.9 p.s.f. (±27.2 mph). During the third test at a static air pressure 5.0 p.s.f. (±44.2 mph), water appeared around the casement operators, on top of the window sill member (Figures 321 and 322) approximately 9 minutes after the start of testing. As previously noted, no staining of any sort was present prior to testing that would indicate leakage had ever occurred in this manner at this window before, and the owner, who was present, did not indicate that leakage had occurred at this window in the past. Observations revealed that the volume of water present on the frame sill at the conclusion of the first and second tests was not enough to pool atop the sill but left only intermittently dispersed areas of water approximately 1 to 2 mm deep, and almost no water was on the underside of the sash (Figures 323 and 324). At the conclusion of the third test, when the window leakage was induced because of the elevated pressure, moisture seeped inward of the frame gasket which allowed entry around the rotary operator, but even then, the

[208] Op. Cit. ASTM E 1105-00, par. 6.2.3, p. 2.

water that had collected atop the flat portion of the window sill was only intermittently dispersed areas of water droplets approximately 1 to 2 mm deep (Figure 325).

3) McIver Specimen B revealed no leakage during the first test at 0 p.s.f. or the second test at approximately 1.3 p.s.f. (±22.5 mph). However, after completion of the second test and after the interior air chamber was removed, moisture was observed atop the sill member of the rough opening underneath the east side of the window (Figure 326).

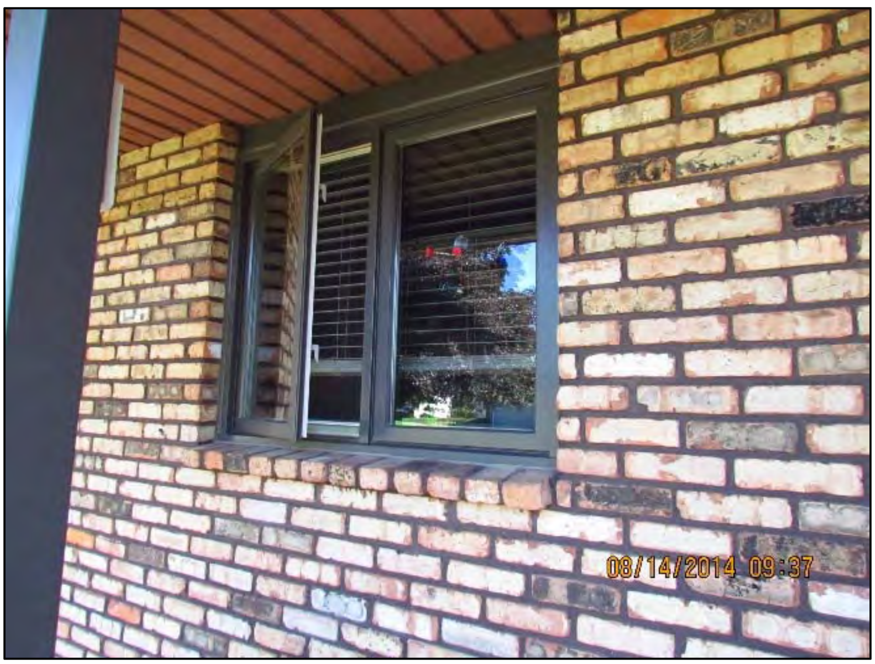

Figure 312

Figure 313

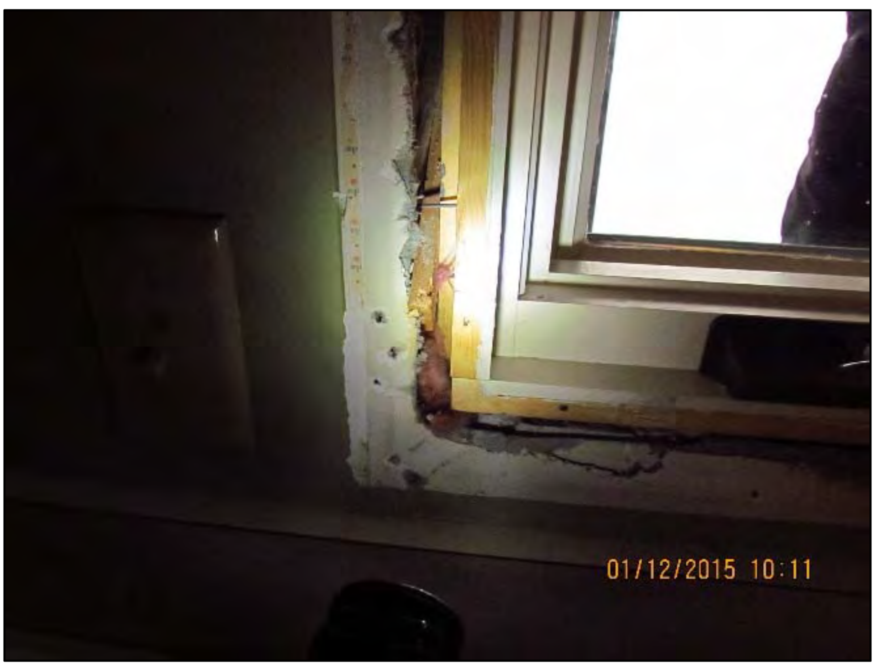

Figure 314

Figure 315

Figure 316

Figure 317

Figure 318

Figure 319

Figure 320

Figure 321

Figure 322

Figure 323

Figure 324

Figure 325

Figure 326

8.6.7 On January 12, 2015, Exponent removed McIver Specimen A and B. GCI's observations of this work were as follows:

a. McIver Specimen A:

1) The window had been installed without the use of Kolbe installation clips as recommended by the Kolbe installation instructions.[209] Also, no fasteners were installed through the window frame or through the brickmould trim. Instead, the window frame was attached only with finishing nails through the jamb extensions and therefore the window frame had no structural support.

2) The window installation instructions require that shims are to be provided at each installation clip.[210] No installation clips were used and shims were only provided on the sill under the two ends of the window. No shims were used along the side of the jambs, head, or between the two shims at the sill.

3) No weather resistive barrier or flashing tape was used to flash the rough opening (Figure 327).

4) 2" x 4" framing lumber was added at the jambs and head to fill in the original rough opening to fit the Kolbe window, but the sill framing appears to be original since it is approximately level with the brick sill, and there is no evidence the row lock sill was replaced. There is no staining on any of the framing lumber except at the east end of the sill towards the exterior edge (Figure 328), but since the sill member is original, and because of the test results, this may pre-date installation of the Kolbe windows.

5) The rough opening is ½" wider and 1⁵/₈" taller than the window unit. The Kolbe installation instructions recommend that the rough opening be ½" larger than the window.[211]

6) The air cavity between the brick and the wall sheathing for water drainage is

---

209 "Casement Window Installation Instructions," Kolbe & Kolbe Millwork Co., Inc., 2000, pp. CW-2 – CW-3, Bates Kolbe 0095177

210 Ibid.

211 Op. Cit. Kolbe Casement Window Installation Instructions, p. CW1, Bates Kolbe 00095176.

approximately ¾" wide rather than the 1" minimum dimension as recommended by the BIA[212] (Figure 329).

7) The Kolbe installation instructions require sealant on the inward side of brickmould where it joins onto window frame.[213] The sealant was not installed (Figures 330).

8) The Kolbe installation instructions require that the sealant on the inward side of brickmould is to seal the top of the jamb brickmould to the head brickmould and to the bottom of the jamb brickmould to the sill horn.[214] The sealant was not installed (Figures 330).

9) There is no water staining or deterioration on the window frames, sashes, or window frame joinery to indicate that leakage has occurred in the past (Figure 330), including the area where leakage was created during the third test. Further, there is no staining or deterioration of the window frame sill member or the bottom of the sashes that corresponds to the design defect allegations outlined in Exponent report.

b. McIver Specimen B:

1) Prior to removal of the window, observations from the interior revealed that daylight is visible between bottom of the window sill and the top of the rough opening (Figure 331) revealing the required sealant was missing or it was improperly installed.

2) The window frame was attached to the structure only using finishing nails. No frame clips, jamb screws, or nails through the brickmould trim were provided.

3) No shims were installed between at the between the window frame and the rough opening as required by the Kolbe installation instructions.[215]

4) No weather resistive barrier or flashing tape was used to flash the rough opening (Figure 332).

5) The rough opening framing lumber appears to be original. There is staining on

212 Op. Cit. BIA Technical Notes 28, August 1991, p. 2
213 Op. Cit. Kolbe Casement Window Installation Instructions, p. CW1, Bates Kolbe 00095176.
214 Ibid.
215 "Double Hung and Slider Window Installation Instructions," Kolbe & Kolbe Millwork Co., Inc., 2000, p. DHSL2, Bates Kolbe 0095181.

framing along the outer edge and at the east end of the opening (Figure 333).

6) The rough opening is approximately $^{3}/_{8}$" wider and 1½" taller than the window. The Kolbe installation instructions recommend that the width and height of the rough opening be ½" larger than the window.[216]

7) The Kolbe installation instructions require sealant on the inward side of brickmould where the brickmould joins onto window frame.[217] This sealant was not installed (Figures 334, 335 and 336).

8) The Kolbe installation instructions require that the sealant on the inward side of brickmould is to seal the top of the jamb brickmould to the head brickmould and to the bottom of the jamb brickmould to the sill horn.[218] The sealant was not installed (Figures 335 and 336).

9) There is staining on the top of the window frame head and on the back of the head brickmould indicating the water enters above the window (Figure 334). The staining continues across the head to the east side (Figure 335) and then down the east jamb to the bottom of the brickmould jamb trim (Figure 336).

9) There is no water staining or deterioration on the window frames, sashes, or window frame joinery, including the east end of the sill, that would indicate leakage entered through the window (Figures 337 and 338).

[216] Op. Cit. Kolbe Double Hung and Slider Window Installation Instructions, 2000, p. DHSL1, Bates Kolbe 0095180.
[217] Ibid.
[218] Ibid.

Figure 327

Figure 328

Figure 329

Figure 330

Figure 331

Figure 332

Figure 333

Figure 334

Figure 335

Figure 336

Figure 337

Figure 338

8.6.8 Summary of McIver Residence Observations:

a. While there may be some evidence of staining and possible deterioration at the McIver residence, there is no evidence that any of the staining or deterioration is attributable to a window design defect. Exponent has opined that sash staining occurs in the Kolbe casement and awning style windows because of the slope of the window sill, the size of the gap between the frame sill and the sash, because of the weather strip on the sash, and because wood on the underside of the sash is not protected by cladding or paint. However, no evidence has been provided that supports these allegations and Exponent ignored all other potential causes of sash staining. In addition, the evidence indicates that the interior of the windows were finished by the owner/contractor, not by Kolbe, and thus any exposed wood that may be able to absorb moisture was not caused by a design defect, and the lone McIver casement window shows no evidence of staining.

b. Numerous construction defects were found that may allow leakage into the building walls, and this leakage can damage the wall, as well as components of the wall such as window frames, resulting in movement, swelling, and distortion, that can affect window performance. In addition, although the Exponent report alleges that exposed wood on the underside of the sash is not protected by cladding or paint and that this can cause sash damage, the evidence indicates that the interior of the windows were finished by the owner or contractor, not by Kolbe, and therefore the ability of the wood to absorb moisture is due to improper finishing by others, not by Kolbe.

c. The windows at the McIver Residence are in generally good condition. No evidence of any design or manufacturing defects was found. Evidence of moisture accumulation was found in the sill of a window on the basement level, and the paint finish on the sills of the other windows in the basement suggest that those windows have also had elevated moisture levels in the past, but the basement windows were installed directly onto clay brick that absorbs moisture and the sealant around the windows is poor. The windows on the second floor level are also poorly sealed to the building and removal of one that was tested indicates that moisture enters above the windows and flows down to the top of the window, then down the sides of the windows to the bottom where it collects on the rough opening sill.

d. Field testing performed at the McIver residence failed to comply with the applicable standards and is unreliable. Water testing performed at McIver Specimen A resulted in leakage, but only when it was tested at a static air pressure differential that was much greater than the averages for the area. Further, the applicable standards require that the objective of forensic testing is to recreate leakage that has been known to occur, but there is no evidence that water leakage has ever occurred at this window in the past. Consequently, the leakage that occurred during the test did not recreate conditions that have been known to occur, but instead, the testing induced new leakage. Field testing at McIver Specimen B resulted in leakage, but it was not observed until after all the testing was completed, including testing at a static air pressure differential that was much greater than the average daily maximum wind speed in the area, and observations

after removal of the window revealed staining patterns that indicate the water leakage was not due to the window, but was due to another cause that was never identified and that the leakage has damaged the window. The evidence indicates that water enters above the window, flows across the top of the window head and then spills off and flows down the side of the window, collecting where the brickmould jamb trim abuts the window sill which has resulted in degradation of the brickmould-to-window frame joint. This joint was not sealed as required by the Kolbe installation instructions. These observations are an example of building construction defects that can cause damage to a window and thereby affect window performance.

e. Removal of the windows from the McIver home revealed that they were not installed properly. Among other things, the window frames were not correctly shimmed or attached to the structure, sealant was not installed on the window brickmould trim where required, no flashing or weather barrier was installed into the rough opening to assure the rough openings were watertight, sealant was not properly installed around the perimeter of the windows, and the rough openings were not properly sized for the windows. Windows that are not properly shimmed and anchored can move out of alignment causing the frame to bow or crown relative to the edge of the sash and this condition can be worsened if moisture or water vapor is also present in the wall. This can result in poor operation of the window as well as poor water drainage from the frame, which can result in deterioration of the sash.

f. Without an examination of the McIver home, and without an examination of the windows after they were removed, it would not be possible to evaluate all of the building components and all the window installation deficiencies that may have an effect on window performance as have been described above.

8.6.9 The McIver home has some conditions and findings that may not be typical of the other class members (see also Tables 1 through 4):

a. Split level home with three different types of exterior wall cladding;

b. Windows were installed as part of a renovation project;

c. Kolbe all wood double hung and casement windows with K-Kron painted exterior finish;
d. Roof overhangs offer little protection to some of the windows;
e. The contractor failed to seal the brickmould-to-wood frame joint on the window frame prior to window installation;
f. The contractor failed to seal the jamb brickmould trim to the head brickmould trim and to the sill horn as required by the installation instructions;
g. The contractor failed to attach the windows to the structure in a manner that complies with the installation instruction and that will assure the window frame is able to withstand applied loading and prevent distortion of the frame members.
h. The contractor failed to properly size the rough openings to fit the replacement windows;
i. The contractor failed to shim the windows as required;
j. Weather records indicate that the maximum daily average wind speed is 16 mph.

8.7 SAMUELS RESIDENCE OBSERVATIONS

8.7.1 On July 29, 2014 GCI inspected the Samuels Residence located at REDACTED [redacted] NH. On May 5, 2015, GCI witnessed field air and water infiltration testing of two windows performed by Exponent.

8.7.2 The Samuels Residence is a two-story single family home over a walkout basement and the property includes a detached two story garage building. A covered entry faces south (Figure 339). The home is located in a rural setting (Figure 340). The detached garage offers some shelter to the eastern exposure (Figure 341). The west (Figure 342) and north (Figure 343) elevations of the home are sheltered to a limited extent by surrounding vegetation although an escarpment on the north may affect wind speeds. Exterior walls are wood frame construction. The roofing is asphalt shingles with gutters and downspouts on the north and south elevations. Conventional roof overhangs provide some protection to openings immediately below the roof line on the north and south elevations, but far less protection is given to openings on the lower levels and to windows in the gable end walls on the east and west elevations. The exterior wall cladding is fiber cement board lap siding. Baseboard strip heating is used on the second floor. There is no forced air heating.

Figure 339

Figure 340

Figure 341